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Northeastern

	Page
General	NE-1
Elkins Research Center	1
Laconia Research Center	2
Frost occurrence in conifer plantations, hardwoods, and open fields	2
Litter accumulation on wind-thrown areas	3
Variation in throughfall	4
Reversal traverses on A-35 recorders	4
October flood	5
Miscellaneous	5
New Lisbon Research Center	6
Single-watershed calibration	6
Soil Moisture Study-Nuclear Meter	7
Publications	7
Manuscripts Submitted	8

NORTHEASTERN FOREST EXPERIMENT STATION

Division of Watershed Management Research

Semi-annual Report April 1960

GENERAL

Laboratories, watershed calibration, a flood, and assorted frost, snow and other studies are the subject of this report. Bob Pierce writes about the new soils lab at Laconia; Bob was also largely responsible for the recent planning of a Northeastern Soils, Frost, and Snow Laboratory. Ken Reinhart and Irv Reigner have pretty well overcome their calibration problems; Ken, in finding that since pre- and post-calibration variances differ, another tack must be taken to determine significance of certain treatment differences; Irv, in finally grinding out the results of his exhaustive, single-watershed calibration. Hubbard Brook weirs were tested by a flood flow in October. Also, this past winter snow and frost studies were conducted out of the Laconia and the Paul Smiths Centers. George Hart gives some of the Laconia findings. At Paul Smiths, in the Adirondacks, Francis Rushmore and company took second-year snow and frost measurements under conifers and hardwoods, collected soil temperature data, and daily measured the depth of snow intercepted on two specially constructed conifers, each with 4 branches, spruce, fir, hemlock, and pine. In the how-to-do-it department Reinhart and Pierce completed their magnus wampus on weir construction, and we got a good start on a solar-radiation manuscript that Bill Reifsnyder (Yale) will co-author.

Among the uncounted (but reported) number of visitors were Dick Marston, Ronald Whipkey, and Larry Hill (CS) to the Fernow to compare programs at nuclear probes. Also, Walt Hopkins (PSW) made a quick tour of Hubbard Brook and the Fernow to see how watershed research is conducted where it rains. We enjoyed their visits: come again, you hear?

ELKINS RESEARCH CENTER

It is now almost two years since the start of treatment in the original Fernow Five gaged watersheds. The effects of the four levels of forest practice on streamflow quantity and quality are very interesting and informative; we are sure they will also be of interest and use to others when we can get them into print. (First findings are in our Station's Annual Report).

Our major efforts in the past several months (in addition to the ever-present record collection) have gone into analysis of data and assembling material for a report covering the first 1-1/2 or 2 years of the treatment period. We expect this will be published soon as a Station Paper.

As expected, numerous knotty problems cropped up during analysis. Early in March, Reinhart and Eschner conferred at length with Al Bickford, Howard Lull and others of the Upper Darby Staff and thrashed out most of the problems.

One of the problems of analysis of watershed data is perhaps worth special mention here. The technique often used for data from paired watersheds (treated and control) with calibration and treatment periods has been analysis of covariance. A prerequisite for this analysis is homogeneity of variance (in the calibration and treatment periods). Of the analyses we are now making, those dealing with storm flows are the only ones with a sufficient number of post-treatment observations to attempt analysis of covariance. Unfortunately, we find that variances are much larger in the treatment period than they were in the calibration period and this analysis is not appropriate.

Pondering the problem, this does not seem surprising; perhaps we even should expect it to be that way. In setting up an experiment, we chose two watersheds as near to identical as possible. Thus in the calibration period we can expect a high correlation between measurements on them. Treatment of one of the two, especially a severe treatment like clearcutting, serves to make them decidedly different. Therefore, it seems only natural that variances in the treatment period will be larger.

We would be interested in comments from others who may have run into the same problem and who have, we hope, come up with magic solutions. In some of our analyses we are using the combination of probabilities as our alternative to analysis of covariance. Credit for this method of "compounding probabilities" is due to R. A. Fisher; it is also presented in Snedecor's Statistical Methods (Fifth Edition, page 216).

LACONIA RESEARCH CENTER

Frost occurrence in conifer plantations, hardwoods, and open field

Results are beginning to come in from a snow and frost study established last fall in a red pine plantation, a white pine plantation (both 40 years old), an oak-northern hardwood (with scattered pine) stand (about 50 years old), and an abandoned cultivated field. The plantations are adjacent and have the same kind of soil (loamy sand).

The occurrence of concrete frost is far less in the red pine than in the white pine plantation. Frost was found in the red pine on only 4 of the 15 sampling days--the white pine had frost 11 out of 15 days.

FROST OCCURRENCE IN PERCENT
(Based on 28 sampling points per plot)

	December			January				February				March			
	15	22	31	6	12	22	26	2	7	16	23	1	8	15	22
White Pine	0	0	0	0	93	50	43	43	4	18	14	4	11	7	4
Red Pine	0	0	0	0	21	39	25	14	0	0	0	0	0	0	0
Hardwoods	0	0	4	0	39	21	14	14	4	4	4	0	11	4	0
Field	4	68	96	39	100	64	75	54	21	0	0	0	3	0	0

Also, the number of points having frost on a given day is considerably less in the red pine than in the white pine. This difference may be attributable to a deeper layer of litter in the red pine. Snow depths are almost the same in both plantations. It is also interesting to find that frost disappeared in the open field once the snow pack became about 20 inches deep. The occurrence and duration of frost in the oak-hardwood stand is greater than we usually find in the northern hardwood stands at Hubbard Brook.

Litter accumulation on wind-thrown areas

The micro-topography on parts of the Hubbard Brook Experimental Forest undulates with mounds and depressions formed by the upturning of tree-root masses by wind. Humus depths are much shallower on mounds than on the slopes or depressions. To get an estimate of how much hardwood litter falls on or accumulates on these positions, we laid out 27 two-foot by two-foot square plots, 9 each on three topographic positions. The plots were marked by dowels stuck into the ground at each corner, and a layer of paint sprayed on the top of the previous year's litter. In making measurements, a string was run around the corner dowels, and all freshly fallen litter was removed down to the paint layer, dried, and weighed.

As expected, accumulation was greatest in the depressions, least on the mounds, and intermediate on the slopes. More than twice as much litter accumulated in depressions as on mounds. In terms of oven-dry weight, there were an average of 3,850 pounds per acre of leaves in depressions and 1,780 pounds per acre on mounds. About 2,570 pounds per acre were found on the

slope positions. These differences in weights of litter are significant at the 5-percent level. These figures fall in the broad range of 2,400-3,000 pounds per acre reported by Chandler for hardwood stands in northern New York.

Variation in throughfall

Another nugget was panned from our interception study. Seventy-two cans were randomly placed in each of three half-acre plots, for a total of 216 cans in an acre and a half. Throughfall was measured in these cans after each storm last summer.

Analysis of the data indicates that the variation between points is inversely related to the size of the storm, as shown below:

Storm 1/ Size (inches)	Throughfall (inches) Ave.	Maximum	Minimum	Standard deviation	Coefficient of variation
.040	.019	.056	.000	.011	58%
.116	.072	.280	.010	.030	42
.144	.096	.158	.031	.024	25
.249	.192	.311	.082	.046	24
.278	.190	.306	.127	.032	17
.400	.326	.474	.143	.057	17
1.022	.840	1.142	.515	.126	15

1/ Based on catch in open.

At a given point, throughfall was seldom consistently greater or less than the average catch in the stand. Spherical densiometer measurements of the canopy over each can did not show any relationship between canopy density and through-fall.

Reversal traverses on A-35 recorders

Is our face red!! We have been making numerous corrections for chart expansion on our Stevens A-35 water level recorders. We detect this

expansion (or contraction) by running the recorder through a reversal at the upper and lower margins of the chart. If the reversal points fall inside the chart margins, we assume the chart has expanded. But--and here is the embarrassing point--when we installed the recorders, we apparently failed to make sure that the length of the trace from lower to upper reversal was exactly 10.0 inches (our scale is 10":12"). Much of our so-called expansion was, we feel, is due to an incorrect setting of the length of the traverse between reversing points.

We are still digging into the problem and we may be able to eliminate corrections for expansion or contraction by adjusting the length of the traverse to accommodate the expansion.

October flood

A "once-in-a-lifetime" storm hit Hubbard Brook last October and dumped about 8 inches of rain in a 48-hour period. This part of New England had not had a storm with as much runoff since 1927.

Fortunately, our weirs held and were not overtopped--but there was not much leeway. Weir 3, our largest, is a 2-foot 120° V-notch with a 16-foot horizontal section above the "V". The capacity of the "V" (about 24 cfs) was exceeded--67 cfs occurred at the peak, or 450 csm.

Sediment and debris accumulated to such an extent in the weir basin that normal discharge relationships were very likely thrown off. Calculation of discharge in excess of the V-notch section was very crude because of an unknown velocity of approach. As far as we know, there have been no data published for rating compound weirs; e.g., a v-notch combined with a horizontal section above. If anyone has information on rating such weirs, we would appreciate receiving it.

Miscellaneous

As reported in the last issue, we contracted building of Weir 4. It isn't finished yet, although we can start measurement of spring runoff. Once excavation was completed, it was necessary to shift the placement, and alter the dimensions. This meant time-consuming changes in contract specifications. As a result of this experience, we are thinking of excavating on an hourly basis and building the weir on force account.

Our new 900-square-foot soils and Biological Laboratory has recently been completed in the basement of the Forestry Building at Laconia, New Hampshire. Space and facilities are now available for research in forest soils, forest pathology, and tree physiology. The lab will enable us to start investigations of soil characteristics, water quality, and tree physiology as related to watershed management.

The physical plant includes a main general-purpose laboratory with four smaller rooms for specialized activities--soil and tissue grinding, biological culture transfer, instrumentation and weighing, and a dark room for combined photographic and plant control work.

NEW LISBON RESEARCH CENTER

Single-watershed calibration

All refinements and recalculations of this long-lasting study have been completed, and the procedures are being written for publication. The results are expected to appear in at least three publications: a concise statement of background and results for the American Geophysical Union's Transactions; a somewhat longer version will be included in Dilldown Report No. 4 which is nearly ready for publication by the Pennsylvania Department of Forests and Waters; a Station paper will present the full background and the evolution of the final methods (including blind alleys).

In brief, the Dilldown Watershed is calibrated on the basis of annual yield and monthly yield by groundwater level groups. The latter are closely related to seasons; the warm-season months have the lower groundwater levels and are split into two groups based on beginning groundwater level. May and June months form a separate group. Monthly yield predictions are the least accurate in the cold-season months, December through April, because of snow, ice, and frost which confuse the timing of the availability of precipitation to storage accretions and runoff.

Groundwater storage at the beginning of a month has a great effect on monthly runoff and a method has been devised to estimate it from antecedent precipitation and temperature data. This parameter and an expression of daily weighted precipitation are the two most important variables affecting monthly yield. Other differences between months are related to length of day and monthly temperatures.

Annual yields may be predicted with an equation including annual precipitation, an expression of annual temperature, and an estimate of storage change. The latter is based on precipitation and temperature differences.

Although the procedures involved are somewhat complicated and require fairly lengthy calculations, they are not high-powered. The relationships are logical and understandable and have provided considerable incidental information on the disposition of moisture within a watershed.

Soil Moisture Study-Nuclear Meter

A nuclear soil moisture meter needing repairs was obtained last summer from the Elkins Research Center. It was subsequently repaired with little difficulty by the manufacturer, William B. Johnson and Associates, located in Boonton, N. J., close to the Newark Watershed.

John Phillips, who handled the meter at the Elkins Research Center, is our expert, and the rest of us are still learning to use it. Although there was some question as to its capabilities in our very light soils with very low moisture contents, so far the results obtained have been quite reasonable.

Recently the meter was taken back to West Virginia where it was compared with a Nuclear-Chicago meter brought in from the Central States. Soil moisture estimates varied by only one percent between meters. It would appear that the Johnson meter may be better for our light soils as it uses a rate meter rather than a scaler. The scaler requires a long count, up to 6 minutes, at low moisture levels, while the rate meter is read with the same degree of accuracy at any moisture level.

Access tubes for the nuclear probe will now be installed in the soil moisture plots established last year. Gravimetric sampling will continue, however, until the meter is calibrated and until complete confidence in the meter is attained.

PUBLICATIONS

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A time-corrector device for adjusting streamflow records. Raymond W. Lavigne. Northeast. Forest Expt. Sta. Note 98, 4 pp., 1960.

The Baltimore watershed...an example of good management. Irvin C. Reigner and Walter C. Sushko. Public Works 91: 85-88, 1960.

Watershed management research in the Northeast. Howard W. Lull. Jour. Forestry 58: 285-287, 1960.

Manuscripts Submitted

Effects of cutting northern hardwoods upon humus depths. George E. Hart, Jr.

Automatic apparatus to take water quality samples and to remove trash screens from weirs. K. G. Reinhart, R. E. Leonard, and G. E. Hart, Jr.

Snow accumulation and melt under certain forest conditions in the Adirondacks. Howard W. Lull and Francis Rushmore.

Prospects in the Northeast for affecting the quantity and timing of water yield through snowpack management. Howard W. Lull and Robert S. Pierce.